DEVELOPMENT OF BIOGRANULES USING SELECTED MIX CULTURE OF DECOLOURISING BACTERIA FOR TREATMENT OF TEXTILE WASTEWATER

KEE THUAN CHIEN

UNIVERSITI TEKNOLOGI MALAYSIA

DEVELOPMENT OF BIOGRANULES USING SELECTED MIX CULTURE OF DECOLOURISING BACTERIA FOR TREATMENT OF TEXTILE WASTEWATER

KEE THUAN CHIEN

A thesis submitted in fulfilment of the
requirements for the award of the degree of
Master of Science (Bioscience)

Faculty of Biosciences and Bioengineering
Universiti Teknologi Malaysia

NOVEMBER 2012

Specially dedicated to my family members

ACKNOWLEDGEMENT

People from all walks of life have contributed towards my comprehension and completion of this study. In particular, I wish to convey my upmost gratitude to the main thesis supervisor, Assoc. Prof. Dr. Zaharah Bt. Ibrahim and my co-supervisor, Dr. Khalida Bt. Muda for their aid in supervision and encouragement. Their continued support was the key factor in the completion of this thesis. Million thanks to Kuok Foundation for financially supported this study. I will be sure to fulfill the promise to pledge myself in serving and bring contribution to my country.

I am also feeling grateful to Universiti Teknologi Malaysia (UTM) in providing top facilities for my study and research. Staffs of biochemical lab and research lab 2 from Faculty of Biosciences and Bioengineering as well as Civil Engineering Environmental Department also deserves special thanks for their assistance in this study. I am greatly indebted to my fellow postgraduate friends and undergraduate juniors for their sincere advice and supports. Last but not least, greatest appreciation to all my family members for their unconditional love and care. Once again, for those who are not listed in this limited space, you have my sincere gratitude for your assistance at various occasions. Thank you.

ABSTRACT

Biological treatment of textile wastewater using granules involves the application of self-immobilisation of high density biomass under intermittent facultative anaerobic and aerobic system. Since granules are dense and have high settling velocity, high density of active biomass to be retained without being washed out, minimising previous problems of using suspended biomass in treating textile wastewater. The use of synthetic wastewater containing single or several combinations of dyes for the development of granules has been widely studied. However, little has been reported on the development of granules using more complex and toxic real textile wastewater. Hence, there is a need to develop granules that are well adapted to real textile wastewater in order to improve the treatment efficiency. In this study, granules consisting of bio-augmented consortium of four locally isolated decolourising bacteria were successfully developed under intermittent facultative anaerobic-aerobic system. Sludge was added as seeding agent in a single 1 L SBR reactor at hydraulic retention time (HRT) of 6 h. The 16S rDNA molecular analysis showed that ZK1 (JQ773350), ZK2 (JQ773351), ZB1 (JF742762) and ZB2 (JF742761) were closely related to *Bacillus pumilus*, *Bacillus cereus*, *Brevibacillus panacihumi* and *Lysinibacillus fusiformis* respectively. After 112 days, the size of the granules reached 3.3 ± 1 mm and were dark grey in colour, with integrity coefficient of 25 ± 2, settling velocity of 56 ± 5 m h^{-1} and sludge volume index (SVI) of 35 ± 5.5 mL g^{-1}. Biomass concentration was 13 ± 0.8 g L^{-1} and 11 ± 0.6 g L^{-1} for MLSS and MLVSS respectively. In general, the developed granules showed good removal for colour (70 %; initial ADMI values ranging from 500 to 2000) and COD (53 %; initial values ranging from 400 to 1,500 mg L^{-1}) at HRT of 24 h with intermittent facultative anaerobic (18 h) and aerobic (6 h).

ABSTRAK

Rawatan biologi air sisa tekstil dengan granul melibatkan pengumpalan biojisim berkepekatan tinggi dalam sistem olahan berselang seli fakultatif anaerobik dan aerobik. Dengan ketumpatan dan halaju enapan yang tinggi, granul yang terdiri daripada biojisim aktif yang berkepekatan tinggi dapat dikekalkan dalam reactor dan ini mengurangkan masalah penggunaan biojisim terampai dalam rawatan sebelum ini. Air sisa sintetik dengan satu atau kombinasi perwarna telah diguna secara meluas untuk pembentukan granul. Namun, pembentukan granul dengan air sisa tekstil mentah yang lebih kompleks dan toksik jarang dilaporkan. Oleh itu, keadaan ini menjanakan permintaan untuk pembentukan granul yang bersesuaian dengan air sisa tekstil mentah dalam meningkatkan prestasi rawatan., Granul dalam kajian ini terdiri daripada kombinasi empat bacteria penyahwarna diasing daripada kilang tekstil tempatan terbentuk dalam sistem olahan berselang seli fakultatif anaerobik dan aerobik. Enapcemar ditambahkan dalam reactor penjujukan berkelompok 1 L dengan masa tahanan hidraul selama 6 jam. Analisis penjujukan telah mengenal pasti ZK1 (JQ773350), ZK2 (JQ773351), ZB1 (JF742762) and ZB2 (JF742761) masing-masing berkait rapat dengan *Bacillus pumilus*, *Bacillus cereus*, *Lysinibacillus fusiformis* dan *Brevibacillus panacihumi*. Selepas 112 hari, granul terbentuk mencapai saiz 3.3 ± 1 mm dan berwarna kelabu gelap, dengan koefisien intergriti 25 ± 2, halaju enapan purata 56 ± 5 m j^{-1} dan indeks halaju enapan (SVI) 35 ± 5.5 mL g^{-1}. Kepekatan biojisim dalam campuran pepejal terampai (MLSS) dan campuran pepejal terampai sejatan (MLVSS) adalah masing-masing 13 ± 0.8 g L^{-1} dan 11 ± 0.6 g L^{-1}. Secara umumnya, granul yang terbentuk berkeupayaan menyahwarna (70 %; nilai awal Indeks Pembuatan Pewarna Amerika: 500 hingga 2000) dan penyingkiran COD (53 %; nilai awal: 400 hingga 1,500 mg L^{-1}) pada masa tahanan hidraul 24 jam dengan sistem olahan berselang seli fakultatif anaerobik (18 jam) dan aerobic (6 jam).